

I. AMENDMENTS

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings of claims in the application.

Listing of Claims:

Claim 1. (Previously presented) A method for noninvasively determining the concentration of a blood constituent comprising the steps of:

providing a tissue probe, ~~having said tissue probe including~~ a first radiation emitter ~~adapted to emit radiation with~~ having a first wavelength and a first radiation detector ~~configured adapted~~ to receive ~~the first wavelength~~ said radiation after absorbance through a radiation path length of ~~the~~ a patient's blood;

measuring absorbance of ~~the~~ said patient's blood by ~~emitting~~ transmitting said radiation at ~~the~~ said first wavelength through ~~the~~ said patient's blood and detecting ~~the~~ said radiation after passage through ~~the~~ said patient's blood;

varying the volume of said patient's blood through gravitational force to change ~~the said~~ path length of ~~the~~ said tissue probe to provide multiples of said path length;

measuring absorbance of ~~the~~ said patient's blood at each multiple of ~~the~~ said path length; and

determining the concentration of the blood constituent based ~~upon the changing~~ on said measured absorbance.

Claim 2. (Previously presented) The method of ~~claim~~ Claim 1, wherein ~~the~~ said blood constituent comprises hemoglobin.

Claim 3. (Previously presented) The method of ~~claim~~ Claim 1, wherein ~~the~~ said blood ~~is~~ comprises venous blood.

Claim 4. (Previously presented) The method of ~~claim~~ Claim 1, wherein ~~the~~ said blood ~~is~~ comprises arterial blood.

Claim 5. (Previously presented) The method of ~~claim~~ Claim 1, further comprising the step of:

verifying ~~the~~ said determination of concentration by comparing ~~the~~ said radiation path length multiplied by ~~the~~ said determined concentration to ~~the~~ said measured absorbance.

Claim 6. (Previously presented) The method of ~~claim~~ Claim 1, wherein ~~the~~ said step of providing a tissue probe comprises providing a tissue probe having a first and second radiation ~~emitter with a first and second wavelength~~ emitters, said first radiation emitter being adapted to emit first radiation having a first wavelength, said second radiation emitter being adapted to emit second radiation having a second wavelength, and a first and second radiation ~~detector configured~~ detectors adapted to receive ~~the~~ said first and second ~~wavelengths~~ radiations, respectively, after absorbance through a radiation path length of ~~the~~ said patient's blood and wherein ~~the~~ said step of measuring ~~the~~ said absorbance comprises measuring ~~the~~ said absorbance at ~~the~~ said first and second wavelengths.

Claim 7. (Withdrawn) A method for noninvasively determining physiologic parameters of a patient comprising the steps of:

providing a first tissue probe having a first radiation emitter with a first wavelength and a first radiation detector configured to receive the first wavelength after absorbance through a radiation path length of the patient's blood;

measuring absorbance of the patient's blood by emitting radiation at the first wavelength through the patient's blood and detecting the radiation after passage through the patient's blood;

providing a second tissue probe having a second radiation emitter with a second wavelength and a second radiation detector configured to receive the second wavelength after absorbance through a radiation path length;

measuring absorbance at the first and second probes;

performing a determination of hemoglobin absorbance at the first and second probes;

timing the arrival of pulse and flow waves at the first and second probes by comparing the hemoglobin absorbance at the first and second probes; and

determining a cardiac characteristic based upon the arrival of the pulse and flow waves at the first and second probes.

Claim 8. (Withdrawn) A method for noninvasively determining the concentration of a blood constituent of a patient comprising the steps of:

providing a first and second tissue probe each having a first radiation emitter with a first wavelength and a first radiation detector configured to receive the first wavelength after absorbance through a first path length of the patient's blood at a first position relative to the heart of the patient;

measuring absorbance of the patient's blood by emitting radiation at the first wavelength through the patient's blood and detecting the radiation after passage through a first path length of the patient's blood;

varying the volume and pressure of the blood within the first and second probes;

measuring absorbance of the blood as the volume and pressure are varied; and;

computing the concentration of the blood constituent based on the absorbance at the varying pressures.

Claim 9. (Withdrawn) The method of claim 8, wherein the step of varying the pressure of the blood comprises changing the position of the probes relative to the patient's heart.

Claim 10. (Withdrawn) The method of claim 9, wherein the step of computing the concentration comprises calculating the distance the probes have moved relative to the patient's heart.

Claim 11. (Withdrawn) The method of claim 8, wherein the blood constituent comprises hemoglobin.

Claim 12. (Withdrawn) The method of claim 8, wherein the blood is venous blood.

Claim 13. (Withdrawn) The method of claim 8, wherein the blood is arterial blood.

Claim 14. (Withdrawn) The method of claim 8, further comprising the step of: verifying the determination of concentration by comparing the first path length multiplied by the determined concentration to the measured absorbance.

Claim 15. (Withdrawn) The method of claim 8, further comprising the step of changing the path length of the first and second probes.

Claim 16. (Withdrawn) The method of claim 8, wherein the step of providing a first and second tissue probe comprises providing a first and second tissue probe each having a first and second radiation emitter with a first and second wavelength and a first and second radiation detector configured to receive the first and second wavelengths, respectively, after absorbance through a first path length of the blood and wherein the step of measuring the absorbance comprises measuring the absorbance at the first and second wavelengths.

Claim 17. (Withdrawn) A method for noninvasively determining physiologic parameters of a patient comprising the steps of:

providing a first and second tissue probe each having a first radiation emitter with a first wavelength and a first radiation detector configured to receive the first wavelength after absorbance through a radiation path length of the patient's blood at a first position relative to the heart of the patient;

measuring absorbance of the patient's blood by emitting radiation at the first wavelength through the patient's blood and detecting the radiation after passage through the radiation path length of the patient's blood;

varying the volume and pressure of the blood within the first and second probes;

measuring absorbance of the blood as the volume and pressure are varied;

timing the arrival of pulse and flow waves at the first and second probe by comparing the hemoglobin absorbance at the first and second probe; and

determining a cardiac characteristic based upon the arrival of the pulse and flow waves at the first and second probes at the varying pressures.

Claim 18. (Withdrawn) The method of claim 17, further comprising the step of using an electrocardiogram to correlate timing of the absorbance measurements.

Claim 19. (Withdrawn) A method for noninvasively determining the pH of blood of a patient comprising the steps of:

providing a first tissue probe having a first and second radiation emitter with a first and second wavelength, respectively, and a first and second radiation detector configured to receive the first and second wavelength, respectively, after absorbance

through the patient's blood, wherein the absorbance of the first wavelength depends upon the pH of the blood and wherein the absorbance of the second wavelength is substantially independent of the pH of the blood;

measuring absorbance of the patient's blood by emitting radiation at the first and second wavelength through the patient's blood and detecting the radiation after passage through the patient's blood; and

computing the pH of the blood based upon the measured absorbance at the first and second wavelengths.

Claim 20. (Withdrawn) The method of claim 19, wherein the first and second wavelengths are chosen based upon the absorbance of species of hemoglobin.

Claim 21. (Withdrawn) The method of claim 20, wherein the species of hemoglobin are selected from the group consisting of methemoglobin, oxyhemoglobin, deoxyhemoglobin, and carboxyhemoglobin.

Claim 22. (Withdrawn) The method of claim 20, wherein the first wavelength is selected from the group consisting of about 535 nm, about 577 nm and about 600 nm and the second wavelength comprises a near infrared wavelength.

Claim 23. (Withdrawn) The method of claim 19, further comprising the step of varying the blood temperature.

Claim 24. (Withdrawn) The method of claim 19, further comprising the steps of: providing a second tissue probe having a first and second radiation emitter with a first and second wavelength, respectively, and a first and second radiation detector configured to receive the first and second wavelength, respectively, after absorbance through the patient's blood, wherein the absorbance of the first wavelength depends upon the pH of the blood and wherein the absorbance of the second wavelength is substantially independent of the pH of the blood;

measuring absorbance of the patient's blood at the first and second probe; computing the pH of the blood based upon the measured absorbance at the first and second wavelengths at the first and second probes; and

determining the temperature of the blood based upon the computed pH.

Claim 25. (Withdrawn) The method of claim 24, wherein the first probe measures absorbance of venous blood and the second probe measures absorbance of arterial blood.

Claim 26. (Withdrawn) A method for non-invasively determining the concentration of a blood constituent comprising the steps of:

- measuring absorbance of arterial and venous blood;
- determining arterial and venous oxygen saturation;
- subtracting hemoglobin absorbance based upon the arterial and venous saturation;

and

- determining the concentration of a blood constituent based upon remaining absorbance.

Claim 27. (Withdrawn) The method of claim 26, wherein the blood constituent comprises glucose.

Claim 28. (Withdrawn) The method of claim 27, further comprising the steps of measuring absorbance at a plurality of wavelengths and comparing arterial and venous absorbance at each wavelength.

Claim 29. (Withdrawn) A method for non-invasively determining a chemical analyte in a patient's blood comprising the steps of:

- providing a tissue probe comprising a film containing a known concentration of the analyte;

- measuring absorbance of the film and tissue of the patient;
- changing the blood volume of the patient's tissue by raising or lowering the tissue relative to the patient's heart; and

- comparing tissue absorbance to film absorbance to determine the relative concentration of the analyte in the patient's tissue to that in the film.

Claim 30. (Withdrawn) A method for non-invasively determining a cardiac characteristic of a patient comprising the steps of:

- measuring pulse wave velocity in a first extremity;
- determining flow wave velocity; and
- computing the cardiac output characteristic using the flow wave velocity.

Claim 31. (Withdrawn) The method of claim 30, wherein the step of computing the cardiac characteristic comprises determining a characteristic selected from the group comprising cardiac output, cardiac index, cardiac stroke volume, cardiac ejection fraction, and blood volume.

Claim 32. (Withdrawn) The method of claim 30, further comprising the step of measuring pulse wave velocity in a second, opposite extremity and wherein the step of determining flow wave velocity comprises computing the flow wave velocity using the ratios of the pulse wave velocities in the first and second extremities.

Claim 33. (Withdrawn) The method of claim 32, wherein the first and second extremities comprise the patient's hands.

Claim 34. (Withdrawn) The method of claim 32, wherein the steps of measuring pulse wave velocity comprise measuring the time intervals for arrival of pulses in the first and second extremities.

Claim 35. (Withdrawn) The method of claim 30, further comprises the step of measuring blood pressure and wherein the step of determining flow wave velocity comprises computing the flow wave velocity using the blood pressure and the pulse wave velocity.

Claim 36. (Withdrawn) The method of claim 32, wherein the steps of measuring pulse wave velocity comprises the steps of placing tissue probes on different locations of the patient's body, continuously monitoring oxygen saturation in the patient's blood through the tissue probes, inducing a change in oxygen saturation, and comparing the arrival time of the saturation change at the tissue probes.

Claim 37. (Withdrawn) The method of claim 36, wherein the step of inducing a change in oxygen saturation comprises having the patient breath-hold.

Claim 38. (Withdrawn) The method of claim 30, further comprising the step of inducing a change in oxygen saturation.

Claim 39. (Withdrawn) The method of claim 38, wherein the cardiac characteristic is selected from the group comprising cardiac index, cardiac stroke volume and cardiac output, and the cardiac characteristic is computed by determining the time interval between the inducement of change in oxygen saturation and a first measured change in oxygen saturation.

Claim 40. (Withdrawn) The method of claim 38, wherein the cardiac characteristic comprises cardiac ejection fraction and the cardiac characteristic is computed by determining the time interval between a first measured change in oxygen saturation and maximal change in oxygen saturation.

Claim 41. (Withdrawn) The method of claim 38, wherein the cardiac characteristic comprises blood volume and the cardiac characteristic is computed by determining the time interval between the inducement of change in oxygen saturation and return to a baseline measured oxygen saturation.

Claim 42. (Withdrawn) The method of claim 36, wherein the step of inducing a change in oxygen saturation comprises providing an enriched oxygen atmosphere.

Claim 43. (Withdrawn) A method for noninvasively determining the blood pressure of a patient comprising the steps of:

- measuring the pulse wave velocity in a first extremity of the patient at a first pressure;

- inducing pressure change in the first extremity;

- measuring the pulse wave velocity in the first extremity at a second pressure; and

- computing the blood pressure using ratios of the pulse wave velocities and the hydrostatic pressure difference of the first and second pressures.

Claim 44. (Withdrawn) The method of claim 43, wherein the step of inducing pressure change in the extremity comprises varying the height of the extremity relative to the patient's heart.

Claim 45. (Withdrawn) The method of claim 43, further comprising the step of measuring pulse wave velocity in a second extremity.

Claim 46. (Withdrawn) The method of claim 45, further comprising the step of inducing pressure change in the second extremity.

Claim 47. (Withdrawn) A method for noninvasively determining the blood pressure of a patient comprising the steps of:

- measuring the time interval for a pulse to reach a given point in a first extremity at a first pressure

- inducing pressure change in the extremity by varying the height of the first extremity relative to the patient's heart;

measuring the time interval for a pulse to reach the given point in the first extremity at a second pressure; and

computing the blood pressure using the ratios of the time intervals and the hydrostatic pressure difference of the first and second pressures.

Claim 48. (Withdrawn) The method of claim 47, further comprising the step of measuring the time interval for a pulse to reach a given point in a second extremity.

Claim 49. (Withdrawn) The method of claim 48, further comprising the step of inducing pressure change in the second extremity.

Claim 50. (Withdrawn) A method for noninvasively determining a patient's blood pressure comprising the steps of:

measuring pulse wave velocities in two opposite extremities; and

computing the blood pressure using the ratios of the pulse wave velocities.

Claim 51. (Withdrawn) A method for noninvasively determining the blood pressure comprising the steps of:

measuring the time intervals for arrival of a pulse in two opposite extremities; and

computing the blood pressure using the ratios of the two time intervals.

Claim 52. (Withdrawn) A method for noninvasively determining a patient's central venous pressure comprising the steps of:

elevating an extremity to a first position relative to the patient's heart;

continually measuring light absorbance in the extremity;

lowering the extremity to a second position relative to the patient's heart, wherein the second position comprises a position where light absorbance in the extremity increases with respect to light absorbance at the first position; and

computing central venous pressure using the hydrostatic pressure difference between the first position and the second position.

Claim 53. (Previously presented) A method for noninvasively determining the concentration of a blood constituent comprising the steps of:

providing a at least one tissue probe, having said tissue probe including a first radiation emitter ~~with~~ adapted to emit radiation having a first wavelength and a first radiation detector ~~configured~~ adapted to receive ~~the first wavelength~~ said radiation after absorbance through a first path length of ~~the~~ a patient's blood;

measuring absorbance of ~~the~~ said patient's blood by ~~emitting~~ transmitting said radiation at ~~the~~ said first wavelength through ~~the~~ said patient's blood and detecting ~~the~~ said radiation after passage through ~~the~~ said patient's blood;

~~calculating~~ determining absorbance values of ~~the~~ said patient's blood at multiples of ~~the~~ said path length; and

determining the concentration of the blood constituent based ~~upon the changing~~ on said absorbance values.

Claim 54. (Withdrawn) A method for noninvasively determining the concentration of a blood constituent comprising the steps of:

providing a tissue probe having a first radiation emitter with a first wavelength and a first radiation detector configured to receive the first wavelength after absorbance through the patient's blood;

measuring absorbance of the patient's blood by emitting radiation at the first wavelength through the patient's blood and detecting the radiation after passage through the patient's blood;

varying the saturation of the blood;

measuring absorbance of the patient's blood at the varied saturation; and

determining the concentration of the blood constituent based upon the absorbance at the varied saturations.

Claim 55. (Canceled)

Claim 56. (Previously presented) The method of Claim 53, wherein said blood constituent comprises hemoglobin.

Claim 57. (Previously presented) The method of Claim 53, wherein said blood comprises venous blood.

Claim 58. (Previously presented) The method of Claim 53, wherein said blood comprises arterial blood.

Claims 59 - 61. (Canceled)